COSEWIC
Assessment and Status Report

on the

Puget Oregonian Snail
Cryptomastix devia

in Canada

EXTIRPATED
2002

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION DES
ESPÈCES EN PÉRIL
AU CANADA

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COSEWIC
Assessment Summary

Assessment Summary – November 2002

Common name
Puget oregonian snail

Scientific name
Cryptomastix devia

Status
Extirpated

Reason for designation
In Canada, this species was known previously (1850-1905) from only three old records from Vancouver Island and southwestern mainland of British Columbia. In spite of surveys of 38 forested localities in 1986 and 450 localities since 1990 for terrestrial gastropods and 142 localities specifically to locate *C. devia* (total of about 110 person hours) no specimens have been found. Regions in which known localities for *C. devia* were said to have occurred have been heavily impacted by urbanization and agricultural use.

Occurrence
British Columbia

Status history
Designated Extirpated in November 2002. Assessment based on a new status report.

COSEWIC
Executive Summary

Puget Oregonian Snail
Cryptomastix devia

Species information

The Puget oregonian snail is a member of the family Polygyridae, a large and diverse group of land snails endemic to North America. The shell of adults is 18–25 mm in diameter, pale yellowish to brown, and globose in form. The apertural lip of the shell is pale and broadly expanded, and a distinct, white, tooth-like structure (parietal denticle) is present within the aperture. The shell of juveniles contains short, microscopic, hair-like projections and lacks the parietal tooth and developed apertural lip of adults.

Distribution

The Puget oregonian snail occupies the western Cascade Range and Puget Trough, and its geographic range extends south from southwestern British Columbia through western Washington State to the Oregon side of the Columbia Gorge in the United States. In Canada, the species is known from only three old (1850–1905) records from Vancouver Island and southwestern mainland of British Columbia. There are no recent Canadian records.

Habitat

In the United States, the Puget oregonian snail is a mature forest specialist and inhabits moist old-growth and late successional forests and riparian areas at low and middle elevations. Essential habitat attributes for the species are thought to include shade provided by forest canopy, which conserves moisture and ameliorates fluctuations in temperature and moisture conditions on the forest floor; coarse woody debris and leaf litter for escape cover and oviposition sites; and mycorhizae and associated fungi for food.

Biology

Little is known of the ecology and life history of the Puget oregonian snail, and no specific information is available for the species in Canada. The snails are hermaphroditic, lay eggs, and may be slow-maturing and long-lived. Their dispersal

ability is probably poor, based on the scattered distribution pattern of the species throughout its geographic range.

Population sizes and trends

There are no extant populations of the Puget oregonian snail known from Canada. The last record of the species was at least 96 years ago, and it is assumed that the size of the Canadian population is zero. The species may never have been common or widespread here. In the United States, its distribution is distinctly patchy, and the number of populations appears to be decreasing.

Limiting factors and threats

Habitats in the vicinity of both reported historical localities of the Puget oregonian snail in British Columbia have undergone extensive habitat loss and fragmentation, and the quality of remaining forested habitat patches has deteriorated. The Esquimalt area on Vancouver Island (site of a historical record) has been urbanized and lies now within Greater Victoria. Changes have also been extensive on the lower mainland of British Columbia, and little original wooded habitat remains. These trends continue today, and remaining habitat patches in both areas are under pressure from expanding urban development.

The minimum size of habitat patches that can support populations of the Puget oregonian snail is unknown, but the species appears to persist in a few forested parks within the metropolitan Seattle area in Washington State, indicating that survival within populated areas is possible. Canadian populations, if they still exist, would be threatened by various anthropogenic factors, including habitat loss and fragmentation, and competition from introduced species of gastropods, and thus would be very vulnerable.

Special significance of the species

The presence of the Puget oregonian snail in Canada is of both scientific and conservation interest, as populations at the northern limits of their geographical range might possess unique adaptations. Relatively few native, large land snails inhabit west coast forests in British Columbia, and the presence of the Puget oregonian snail would be a significant contribution to the biodiversity of the forest floor fauna.

Existing protection or other status designations

Assessments of terrestrial gastropods for the provincial red and blue lists are yet to be conducted. In the United States, the Puget oregonian snail is on the list of "Survey and Manage" species under the Northwest Forest Plan (governing the management of mature and old-growth forest on federal lands from Washington State to northern California) and is considered to be at risk from forest-harvesting activities.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

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COSEWIC Status Report

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SPECIES INFORMATION

Name and classification

The Puget oregonian snail, *Cryptomastix devia*, was described by Addison A. Gould (1846:165) as *Helix devia* from material collected in 1841 by the United States Exploring Expedition. A junior synonym, *Helix baskervillei* Pfeiffer, 1850:130, was based on a specimen from "Vancouver's Island," British Columbia.

Cryptomastix devia (Gould, 1846) is a member of the family Polygyridae (Mollusca: Gastropoda: Pulmonata), a large group of land snails endemic to North America (Pilsbry 1940; Emberton 1994, 1995). It was previously known as *Triodopsis (Cryptomastix) devia* (Pilsbry 1939, 1940), but Webb (1954) demonstrated profound dissimilarities between *Triodopis* and western *Cryptomastix*, and elevated *Cryptomastix* to a full generic rank. This assessment was verified later by Emberton (1994, 1995).

In Canada, the genus *Cryptomastix* is represented by three species: the pygmy oregonian (*C. germana*), the Coeur d'Alene oregonian (*C. mullani*), and *C. devia*; the form known as *C. mullani* may consist of a complex of closely related species. Vagvolgyi (1968) summarized *C. devia* as a monotypic species of limited variation and postulated that is most likely a descendant of *C. mullani*.

The suprageneric classification of the Polygyridae (below) was revised by Emberton (1994) but does not affect the validity of the species. No subspecies of *C. devia* are recognized. The full classification of the species is as follows: Phylum Mollusca: Class Gastropoda: Subclass Pulmonata: Order Stylommatophora: Suborder Sigmurethra: Superfamily Polygyroidea: Family Polygyridae: Subfamily Polygyrinae: Tribe Allogonini: Genus *Cryptomastix*: Subgenus *Cryptomastix*: Species *Cryptomastix devia*.

Cryptomastix means "hidden flagellum" (Greek) and refers to the presence of a vestigial flagellum at the junction of the vas deferens and epiphallus (Pilsbry 1940), a feature of the reproductive anatomy that differentiates the genus from similar-appearing *Triodopsis*. The species name means "out of the way" or "solitary" (Latin).

Description

Cryptomastix devia is the largest member of its genus with a shell diameter of 18–26 mm in adults. The species can be identified by the shell. The adult shell is pale yellowish to brown, globose-heliciform and has 5–6 whorls (Figures 1 & 2). The apertural lip is whitish, broadly expanded and recurved. There is a low bulge present on the basal lip. A prominent white, tooth-like structure (parietal denticle) is present within the aperture. There is a small umbilicus (Pilsbry 1940; Vagvolgyi 1968). The body of the animal is light brown and may have a lilac undertone (Kelley et al. 1999).

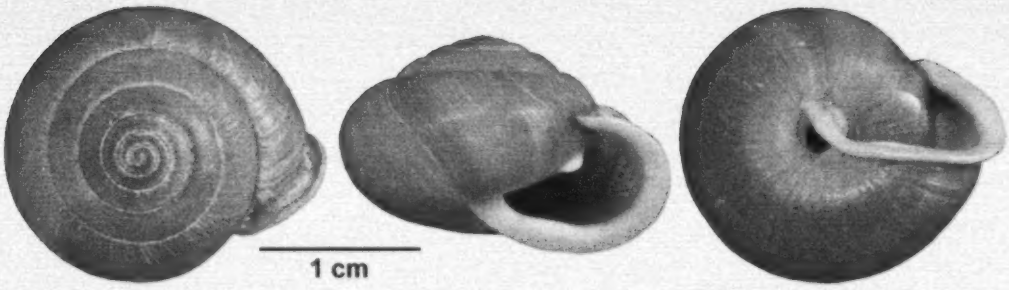

Figure 1. Shell of *Cryptomastix devia* (Washington, U.S.A., specimen). Photograph by R. Forsyth.

Figure 2. Living animal of *Cryptomastix devia* (McAllister Springs, Thurston Co., Washington, U.S.A.). Photograph by W.P. Leonard.

Only on reaching maturity does the apertural lip of the shell become thickened and recurved, and the parietal denticle is formed. Juveniles lack the parietal tooth and developed apertural lip. Juvenile shells have short, fine hair-like periostracal projections, but these are visible only with a minimum of 10× magnification and are often absent in dead specimens (Burke 1999).

The anatomy of the distal reproductive system, especially features of the penis and associated structures, is characteristic of many species of stylommatophoran land snails. Pilsbry (1940, Fig. 496) provided an illustration of the genitalia of *C. devia*.

Few species in coastal British Columbia may be confused with *C. devia*, but three species of polygyrids have the thickened/reflected/recurved apertural lip: the Oregon forestsnail (*Allogona townsendiana*) is a larger species (shell 28–35 mm in diameter) that lacks a parietal denticle; the pygmy oregonian (*C. germana*) is much smaller (shell ≤ 8 mm in diameter) and is covered with long, curved periostracal hairs; and the northwest hesperian (*Vespericola columbianus*) is similar in size to *C. devia* but is densely covered with periostracal hairs and lacks a parietal denticle. Recognition of juveniles can be problematic and is based on the relative tightness of coiling of the whorls, and the presence, density and size of periostracal hairs.

Cryptomastix devia is larger than species/subspecies of the *C. mullani* group that occur in southeastern British Columbia. In *C. devia*, the bulge on the basal lip is located nearer to the columellar than in *C. mullani sensu lato* (Vagvolgyi 1968).

DISTRIBUTION

Global range

Cryptomastix devia occupies the western Cascade Range and Puget Trough, and its geographic range extends south from southwestern British Columbia, through western Washington, to the Oregon side of the Columbia Gorge (Pilsbry 1940; Vagvolgyi 1968; Kelley et al. 1999; Figure 3). The distribution of *C. devia* is separated from that of the *C. mullani* group by the Cascade Range except where the Columbia River cuts through the mountains; there the two species come in contact (Vagvolgyi 1968). The occurrence of *C. devia* is distinctly patchy throughout its range, and in areas where it occurs it is typically found at scattered localities. In the United States, this species is known from 29 localities within 10 larger areas, including parts of the Western Cascade Mountains, Olympic Peninsula, and Willamette (Burke 1999). Knowledge of the species' distribution in the United States has greatly increased since 1994, when it was designated as a "Survey and Manage Species" under the Northwest Forest Plan (governing the management of federal forest lands from Washington to northern California).

Canadian range

There are only three (all before 1905) records of *C. devia* in Canada (Table 1; Figure 4). The junior synonym *Helix baskervillei* Pfeiffer, 1850 was described from Vancouver Island without further locality, based on material in the collection of Hugh Cuming, now in the Natural History Museum (London) (Pfeiffer 1850; Peter Mordan, pers. comm.). However, in many cases, data associated with specimens in the Cuming collection are lacking or suspected to be erroneous (Clench 1945).

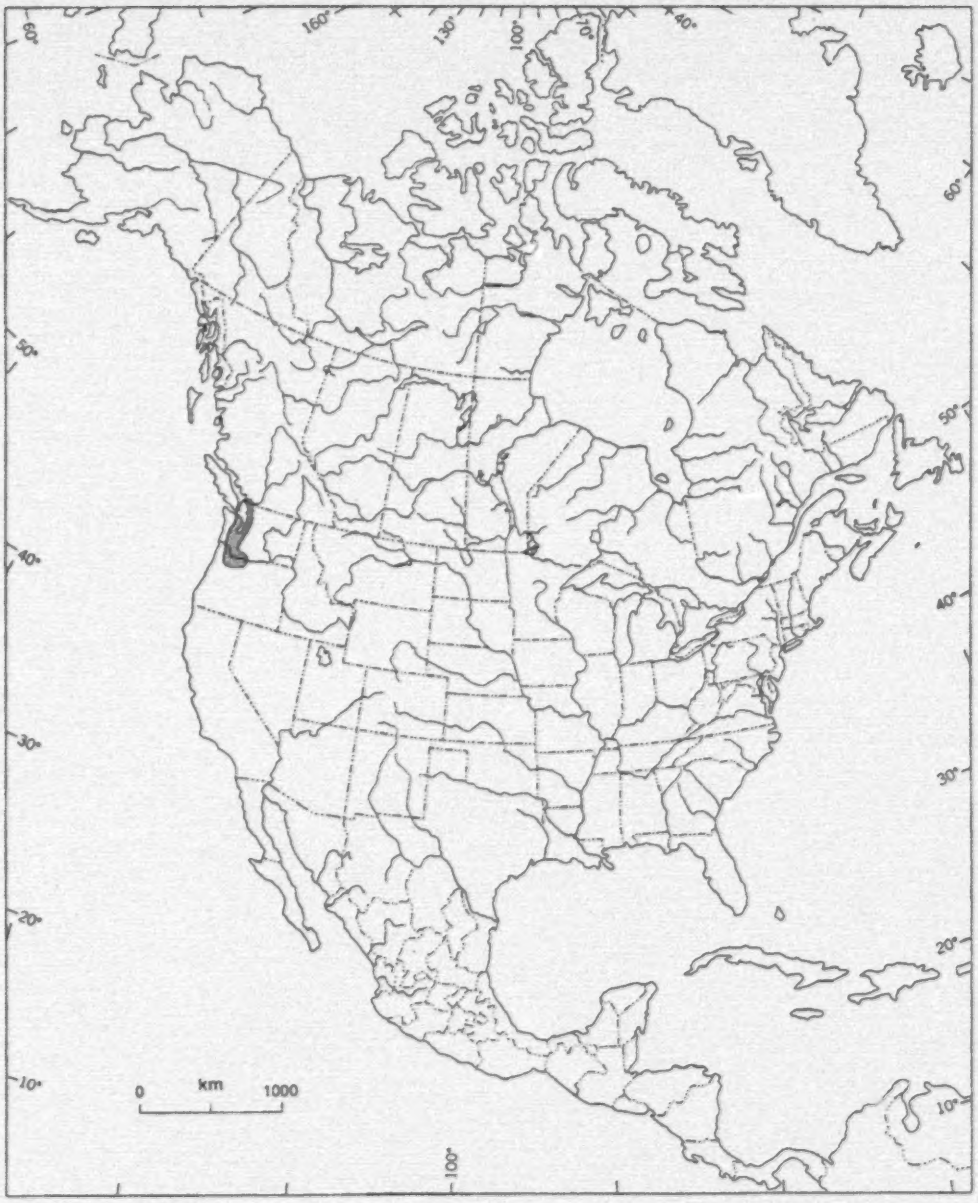

Figure 3. North American distribution of *Cryptomastix devia* (shown as filled, grey area), based on Vagvolgyi (1968:225, Fig. 24).

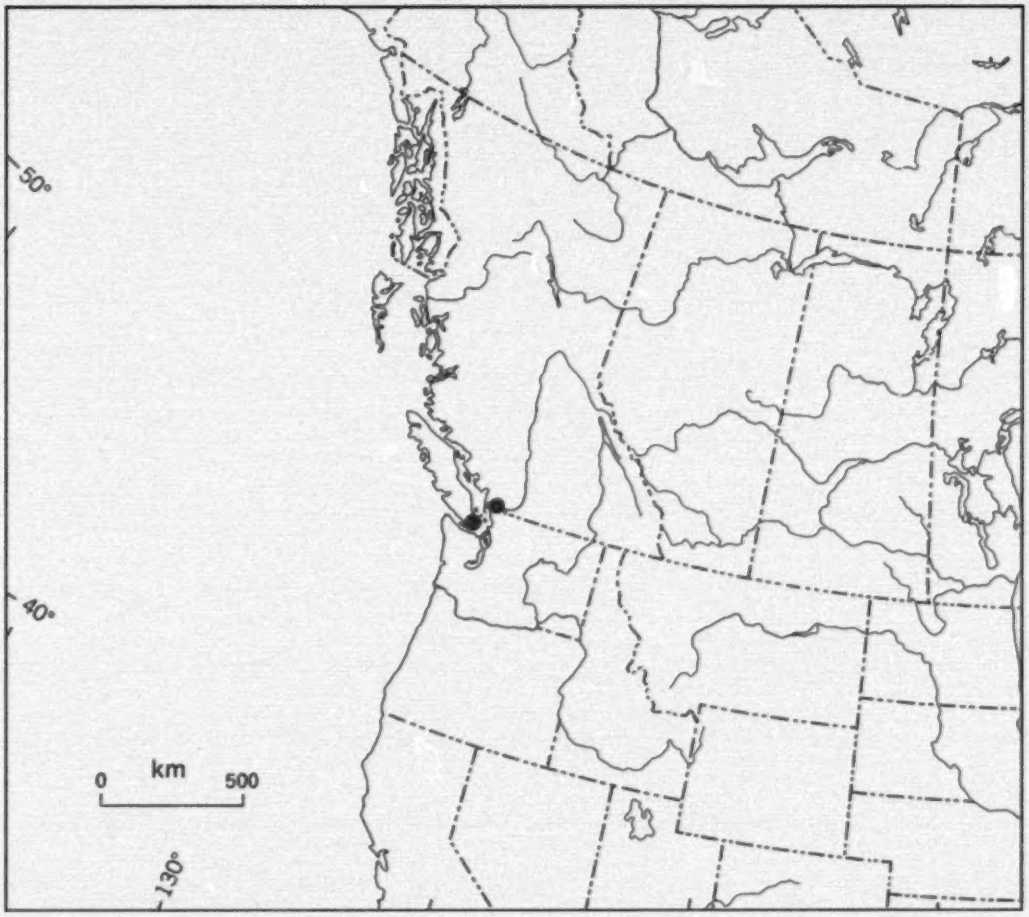

Figure 4. Canadian distribution of *Cryptomastix devia*, based on historical records (see Table 1). Two records are shown as filled circles; the generalized locality of Pfeiffer [1850] is ignored.

Table 1. Historical records for the Puget oregonian snail, *Cryptomastix devia*, in British Columbia.

Name used in citation	Locality	Reference	Notes
Helix baskervillei	Vancouver Island[1]	Pfeiffer 1849:130	Described from material in the H. Cuming collection (Natural History Museum, London)
Mesodon devius	Esquimalt[2]	Taylor 1889:85, 91	
Mesodon devius	Vancouver Island	Taylor 1891a:92	Based on Taylor 1889
Polygyra devia	Esquimalt	Dall 1905:24	Based on Taylor 1889
Polygyra devia	Sumas Prairie[3]	Dall 1905:24	
Triodopsis devia	Vancouver Island	Pilsbry 1940:857	Based on earlier published records
Triodopsis devia	BC	La Rocque 1953:307	Based on earlier published records

[1]Without further locality.
[2]Near Victoria, Vancouver Island, BC.
[3]Present-day Abbotsford/Chilliwack, Fraser Valley, BC.

The second record, also from Vancouver Island, is more reliable. Taylor (1889) reported finding one specimen at Esquimalt, British Columbia, now part of Greater Victoria. The specimen was sent to the prominent American malacologist William G. Binney, who agreed in the identification. Taylor (1889:91) wrote:

> *Mesodon devius*, Gould, sp. [synonym of *C. devia*]
>
> *Helix devia*, Gould, Proc. Bost. Soc. N. H., II, 165 (1846)
>
> I have only seen one specimen of this species from Vancouver Island, and that was taken at Esquimalt, near Victoria. The specimen was sent to Dr. W.G. Binney, who agreed in the identification. *Devius* is not uncommon in Oregon, and was therefore to be expected in Vancouver Island.

From the mainland British Columbia, *C. devia* has been reported only once. Dall (1905) listed it from Sumas Prairie (present-day Abbotsford/Chilliwack), but the source of this record is not evident, nor did Dall indicate that he personally saw a specimen.

Subsequent authors secondarily reported this species from British Columbia, based on these earlier records: Esquimalt (Dall 1905); and Vancouver Island (Taylor 1891; Pilsbry 1940). We were unable to verify whether museum specimens still exist for Taylor's or Dall's records. Most of Taylor's collection was apparently destroyed (Drake 1963). The type specimen of *Helix baskervillei* is held in the Natural History Museum (London), but no further locality information is available other than what was supplied in the original description.

There are no recent records of *C. devia* from Canada. Since 1990, one of us (R. Forsyth) has searched for terrestrial gastropods throughout much of British Columbia, including the south coast, without locating this species (about 450 localities searched on the Lower Fraser Valley and southern Vancouver Island). The species also was not found by Cameron (1986), who surveyed 38 forested localities on Vancouver Island and the Lower Fraser Valley, and by Ovaska et al. (2001), who surveyed 142 localities in these areas in an attempt to locate *C. devia* and other species of terrestrial gastropods deemed rare or potentially at risk. Of the localities surveyed by Ovaska et al. (2001) 44 contained habitat considered suitable for *C. devia* (older forest with bigleaf maple, *Acer macrophyllum*). A total of 70 person-hours were spent searching these areas. In the spring of 2002, Ovaska and Sopuck (2002) surveyed a variety of habitats at three CFB Esquimalt properties near Victoria on southern Vancouver Island for terrestrial gastropods (39.6 person-hours spent searching). Two of these properties (Rocky Point and Mary Hill) are in the Esquimalt area, which is the locality for Taylor's (1889) record. It is likely that the species is extirpated from Canada, although small populations could conceivably still exist.

HABITAT

Habitat requirements

No information exists on habitats of *C. devia* in Canada. In the United States, the species is thought to be a mature forest specialist and inhabits moist old-growth and late successional stage forests and riparian areas at low and middle elevations (below 600 ft [183 m]) (Vagvolgyi 1968; Frest and Johannes 1993; Burke 1999; Kelley et al. 1999). The canopy closure is usually 70% or greater, although occasionally, in wetter situations, the snails have been found in more open stands (Burke 1999). The snails are frequently associated with hardwood debris or talus and are often found under decaying logs or in leaf litter, especially around seepages or springs. Juvenile snails may be found climbing on moss-covered trunks of large bigleaf maple (*Acer macrophyllum*) (Burke 1999). Productive mixed-wood forests with bigleaf maple and swordfern (*Polystichum munitum*) appear to form particularly suitable habitat for the snails (Pilsbry 1940; Kelley et al. 1999). Pilsbry (1940: 858) noted that "this is a form of the humid region, inhabited also by ... *Allogona townsendiana*" (Oregon forestsnail), suggesting that the two species occupy similar habitats. In British Columbia, *A. townsendiana* occupies mixed-wood and deciduous forests, typically dominated by bigleaf maple (Forsyth and Ovaska 2002).

In the United States, essential habitat attributes for *C. devia* are thought to include shade provided by forest canopy, which conserves moisture and ameliorates fluctuations in temperaturature; coarse woody debris and hardwood leaf litter for escape cover and oviposition sites; and mycorhizae and associated fungi for food (Burke 1999). Burke stressed the importance of coarse woody debris, particularly large-diameter, decaying maple logs, as refuges for the snails from predators and adverse weather conditions.

Trends

Habitats in the vicinity of both reported historical localities of *C. devia* from British Columbia, Esquimalt and Sumas Prairie, have been modified extensively within the past century. The area surrounding Esquimalt Harbour on Vancouver Island has been urbanized and now lies within Greater Victoria. European settlement of southern Vancouver Island began with the establishment of a fort at Victoria in 1843. By the end of the 19th century around the time of Taylor's (1889) observation, the population of Vancouver Island was approximately 51,000 people, about 90% of whom were concentrated along the southeast coast from Victoria to Nanaimo (Wood 1979).

The population of Vancouver Island has expanded greatly following resource development throughout the 20th century. This trend continues today, accompanied by greater demands on land. For example, the population of the Victoria Census Metropolitan Area increased by 5.7% within a 5-year period from 1991 to 1996, and the 633-km² area is currently populated by over 300,000 people (Statistics Canada 2001).

The locality where Taylor found *C. devia* more than a century ago almost certainly has been altered beyond recognition.

Sumas Prairie refers to a flat, low-lying floodplain between Sumas and Vedder Mountains in the lower Fraser Valley on southwestern, mainland British Columbia. If accurate, the locality reported by Dall (1905) might have been along the shore of Sumas Lake, which covered about 10,000 acres [4046 hectares] and swelled to up to three times this size after spring floods. Sumas Lake was drained in the early 1920s to reclaim land for agricultural purposes and to control flooding (Sleigh 1999).

Presently the area is extensively farmed, but urbanization of the lower Fraser Valley has proceeded rapidly within the past decade and is likely to continue expanding as the area is within a commuting distance from the city of Vancouver. The human population within both the Abbotsford and Chilliwack Census Agglomerations grew by 20% within a five-year period from 1991 to 1995 (Statistics Canada 2001). Forested hillsides adjacent to and within the lower Fraser Valley could provide refuges for forest-dwelling species, including *C. devia* (if it exists within the area). Pressure for housing developments is primarily in areas such as these, as they are excluded from the Agricultural Land Reserve, which protects against the conversion of surrounding farm land to other purposes.

Protection/ownership

Remnant patches of old growth or mature second growth forest in the area of historic records of *C. devia* are typically small, and their total extent is difficult to estimate. Most lands on southern Vancouver Island and the lower mainland of British Columbia are privately owned, but publicly owned lands also contain some potential habitat for the species. Examples of the latter include lands managed by the Department of National Defence (CFB Esquimalt: Royal Roads, Rocky Point, and Mary Hill areas), Francis/King Regional Park and Goldstream Provincial Park on southern Vancouver Island, and Bridal Veil Falls and Cultus Lake Provincial Parks on the mainland.

BIOLOGY

General

Little is known of the ecology and life history of *C. devia*, and no specific information is available for the species in Canada.

Cryptomastix devia is hermaphroditic and oviparous (Burke 1999). Individuals may be slow-maturing and long-lived. The dispersal ability of the species is probably poor, based on a scattered distribution pattern throughout its geographic range. Canadian populations, if they still exist, would be threatened by various anthropogenic factors, including habitat loss and fragmentation, and competition from introduced species, and

thus would be vulnerable to stochastic events that can result in the extirpation of isolated populations.

Reproduction

Like most terrestrial gastropods, *C. devia* is a simultaneous hermaphrodite. In most terrestrial gastropods, cross-fertilization appears to be the norm, but self-fertilization can occur in at least some species in the absence of potential mates (Runham and Hunter 1970; Duncan 1975). In *C. devia* there is no evidence of self-fertilization, which can be expected to enhance colonization ability. Age at first reproduction is highly variable among land snails, but larger species appear to be relatively slow-maturing, some reaching sexual maturity at the age of 5 years or later (e.g., Pacific sideband, *Monadenia fidelis beryllica*, in captivity, Roth and Pressley 1986).

Like other forest-dwelling land snails, *C. devia* likely requires protected, moist locations for oviposition. Burke (1999) postulated that maintaining adequate structural features of mature forest, including decaying logs, other woody debris, and a layer of litter and duff, would provide the snails with suitable oviposition sites.

Survival

Habitat use patterns of *C. devia* suggest that it might be intolerant of aridity and higher temperatures associated with clearcuts and young forests.

A wide variety of mammals, birds, amphibians, reptiles, and invertebrates prey on land snails. Predation probably constitutes a significant source of mortality of *C. devia* in small, poor-quality habitat patches that lack escape cover (Burke 1999). Carnivorous snails and ground beetles (Coleoptera: Carabidae) are common in habitats occupied by *C. devia* in the United States and are likely predators of all life history stages (Burke 1999). Cychrine ground beetles (tribe Cychrini) in southwestern British Columbia, represented by *Cychrus tuberculatus* and several species of *Scaphinotus*, are predators of terrestrial gastropods (Thiele 1977; Digweed 1993). Carnivorous snails here include several widespread and abundant native, forest-dwelling species (*Haplotrema vancouverense*, *Ancotrema sportella*, and *A. hybridum*). Numerous exotic species could pose a problem (through predation or competition for resources) for any population of *C. devia* that might be found in or near a developed area (Cameron 1986; Forsyth 1999, 2001).

Movements/dispersal

This species is probably relatively sedentary and has poor dispersal abilities, as evidenced by its scattered distribution throughout its geographic range. Fragmentation of habitats by human activities and developments can be expected to pose barriers to dispersal. The snails may occupy different depths of the forest floor in different seasons (Burke 1999), but the extent of their vertical and horizontal movement to and from hibernation and aestivation sites is unknown.

Nutrition

The diet of *C. devia* is unknown, but the snails are probably fungivores/herbivores. Burke (1999) suggested that adults feed primarily on fungal mycelia, as do other members of the family Polygyridae, according to Pilsbry (1940). He also suggested that juveniles, in particular, feed on green plant material in addition to fungi, as evidenced by observations of captive snails.

Behaviour/adaptability

Cryptomastix devia is an inhabitant of older forests and requires attributes of these forests for survival, suggesting that it might have relatively low tolerance limits for changes in temperature and moisture regimes and for alteration of forest floor structure. Due to their patchy distribution, populations in the United States are very vulnerable to extirpation due to stochastic events (Burke 1999). Isolated habitat patches from which snails become extirpated are unlikely to be repopulated through immigration.

Natural catastrophes that can adversely affect land snails include severe weather, such as prolonged droughts, and wildfires. Land snails typically withdraw into their shell during adverse conditions and can seal the aperture with a layer of hardened mucus, thus conserving moisture. Seeking out moist, sheltered microhabitats helps them to survive dry periods in summer and cold periods in winter, and the presence of high-quality escape cover is important in ameliorating fluctuations in ambient temperature and moisture conditions. Populations of terrestrial gastropods appear to be particularly susceptible to high-intensity fires that sweep the forest floor (Burke 1999). Burke noted that in Washington *C. devia* was absent from areas that had been burned as a part of forestry operations.

Cryptomastix devia tolerates some degree of disturbance from human activities, as evidenced by the persistence of populations in small, forested patches within the metropolitan Seattle area (Burke 1999). However, the continued survival of these remnant populations is uncertain, and the degradation of remaining habitats is of concern. The invasion of exotic species and paucity of high-quality escape cover, particularly large-diameter decaying logs, contribute to this degradation. Small habitat patches also experience greater fluctuations in temperature and moisture conditions due to edge effects, thus further reducing their suitability for *C. devia*. Similar considerations apply to potential habitats in the vicinity of reported historic localities for the species in British Columbia.

To our knowledge, *C. devia* has not been bred in captivity. However, like many other terrestrial gastropods, the species can probably be reared in captivity with relative ease. Were a population discovered in Canada, captive breeding or a head-start program (in which juveniles are reared past vulnerable, early developmental stages and then released) might be a feasible option for recovery activities. This would be preferable to using animals from more distant populations in the United States, which may be genetically different.

POPULATION SIZES AND TRENDS

Historical records (especially that of Taylor 1889) suggest that *C. devia* occurred in Canada. However, the species has not been reported from here since then, and it is possible that the species has been extirpated from Canada. Likely, it never was common or widespread. The unlikely possibility remains, however, that the species still exists in small habitat pockets.

In the United States, the distribution pattern of *C. devia* is distinctly patchy, and many of the historical records are from areas that have been urbanized or converted into agricultural lands (Burke 1999). For example, 10 of 18 historical localities in Washington are now within the metropolitan Seattle area. Little actual data are available on population trends, but by inference from habitat trends the number of populations has decreased (Burke 1999). Apart from one specimen found in 2001 on the Oregon Coast Range, no recent records existed from the southern part of the species' historic range (T. Burke, pers. comm.). Where it occurs, *C. devia* typically appears to be less abundant than most other sympatric gastropods (Burke 1999). Burke noted that the snails were fairly abundant in only one area (Cowlitz Valley Ranger District, Gifford Pinchot National Forest, Washington), where it was found at 5 of 40 sites investigated during a four-week period in 1995. The greatest number found at any locality was 6 individuals per visit (search effort was not given). To our knowledge no density estimates are presently available for the species, although Burke (1999) recommended that population densities, trends, and sizes should be monitored at known sites. In the United States concerns exist about the viability of remaining populations, as habitat patches continue to decrease in number, area, and quality (Burke 1999).

LIMITING FACTORS AND THREATS

Burke (1999) identified the following threats to the persistence of populations of *C. devia* in the United States: habitat loss and fragmentation, reduced quality of existing habitats, predation, competition from exotic slugs, high intensity fire, and inadvertent habitat alteration due to other management activities (such as raking of the forest floor for mushrooms and salvaging hardwood logs for firewood after timber harvesting). It is difficult to determine threats and limiting factors for *C. devia* in Canada, because the current existence of populations is unknown.

The historic localities for *C. devia* in southwestern British Columbia represent the northern extremity of the geographic distribution of the species. Species near the limits of their distribution might be particularly vulnerable to climatic fluctuations and stochastic events. Areas in the vicinity of the historic records have undergone extensive habitat loss and fragmentation, and the quality of remaining forested habitat patches has deteriorated. The minimum size of habitat patches that can support populations of *C. devia* is unknown, but the species appears to persist in a few forested parks within the metropolitan Seattle area in Washington State (Burke 1999), indicating that survival in semi-natural remnant forests within populated areas is possible. Efforts to control

introduced gastropods with pesticides could adversely affect the survival of *C. devia* in forested refuges within urban areas or near agricultural fields.

In addition to isolating populations, habitat fragmentation can be expected to render the snails more vulnerable to natural predators, such as carnivorous snails (*Haplotrema* and *Ancotrema* spp.) and carabid beetles. Native snails may also be adversely affected by competition from introduced gastropods, which are prevalent in urban areas and have also expanded into forest habitats.

SPECIAL SIGNIFICANCE OF THE SPECIES

Cryptomastix devia is endemic to the west coast of North America but not exclusive to Canada. Its distribution barely extends to the Canadian side of the border, and current populations, if they still exist, may be relicts from an earlier period when conditions were more favourable.

Of related species (subgenus *Cryptomastix*), only the Mission Creek oregonian (*C. magnidentata*) is on the IUCN Red List (VUD2) (IUCN 2000).

It is unknown if the British Columbia populations of the Couer d'Alene oregonian (*C. mullani*) are at risk; this species exhibits several uninvestigated morphotypes that may represent distinct taxa. In the United States, Frest and Johannes (1995) recommended a status for a number of species and subspecies of *Cryptomastix*, mostly in Idaho. The more distantly related (subgenus *Micranepsia*) pygmy oregonian (*C. germana*) is widespread in coastal British Columbia (Forsyth 2000) and appears to be secure.

Forest-dwelling land snails have ecological importance as consumers of live and decaying vegetation, as decomposers, and as prey for a variety of vertebrate and invertebrate predators. The ecological importance of *C. devia* within its Canadian range was probably limited because of its apparent rarity.

The presence of *C. devia* in Canada would be of both scientific and conservation interest, as populations at the northern limits of their geographical range might possess unique adaptations (Scudder 1989). The presence of such adaptations would contribute to genetic diversity and might enhance the ability of the species to successfully respond to climatic change or other large-scale perturbations. Relatively few native large land snails inhabit coastal forests in British Columbia, and the presence of *C. devia* would make a significant contribution to the biodiversity of the forest floor fauna. *Cryptomastix devia* is the only species of its subgenus on the coast.

We were unable find any evidence of Aboriginal use of land snails for food or for other purposes in southwestern British Columbia (N. Turner, pers. comm.).

EXISTING PROTECTION OR OTHER STATUS

The British Columbia Wildlife Act, which prohibits the collection, handling, and trade of native wildlife species without a permit, does not apply to invertebrates. Native terrestrial gastropods in the province have no legal protection. Assessments of terrestrial gastropods for the provincial red and blue lists are still to be conducted.

Cryptomastix devia is not listed by the World Conservation Union (IUCN 2000) or by the U.S. Fish & Wildlife Service (2001). However, it is on the list of "Survey and Manage" species under the Northwest Forest Plan (Kelley et al. 1999) and is considered to be at risk from forest-harvesting activities. The Plan governs the management of mature and old-growth forest on federal lands from northern California to Washington State. Consequences of the presence of designated species include restricted timber harvesting to maintain suitable habitat conditions.

TECHNICAL SUMMARY

***Cryptomastix devia* (Gould, 1846)**
Puget Oregonian Snail — *Limace du Puget*
British Columbia (Vancouver Island; Fraser Valley)

Extent and Area information	
• *extent of occurrence (EO)(km²)*	[3 pre-1905 records, only]
• *specify trend (decline, stable, increasing, unknown)*	?
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	?
• *area of occupancy (AO) (km²)*	0 known
• *specify trend (decline, stable, increasing, unknown)*	?
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	?
• *number of extant locations*	0 known
• *specify trend in # locations (decline, stable, increasing, unknown)*	NA
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	NA
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	Declining
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	> 1 yr
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	0 known
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	?
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	?
• *are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)?*	?
• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)?*	NA
• *list each population and the number of mature individuals in each*	0 known
• *specify trend in number of populations (decline, stable, increasing, unknown)*	Decline?
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	? [Unlikely]
Threats (actual or imminent threats to populations or habitats)	
Habitat loss, degradation and fragmentation due to urban development	
Rescue Effect (immigration from an outside source)	
• *does species exist elsewhere (in Canada or outside)?*	Yes (Washington & Oregon, U.S.A.)
• *status of the outside population(s)?*	Declining or of concern
• *is immigration known or possible?*	Unlikely or not possible
• *would immigrants be adapted to survive here?*	Possibly
• *is there sufficient habitat for immigrants here?*	Possibly
Quantitative Analysis	

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Kristiina Ovaska, Ph.D., M.Sc., received her doctoral degree (biology) from the University of Victoria in 1987, after which she completed two post-doctoral studies in population biology and ecology of amphibians. Currently, she is senior ecologist with Biolinx Environmental Research Ltd. (Sidney, British Columbia) and research associate at the Department of Forest Sciences, University of British Columbia. Over the past 15 years, Dr. Ovaska has prepared several environmental impact assessments and status reports and conducted research on a variety of wildlife (vertebrates and invertebrates), including endangered species. She is the author of more than 30 publications in refereed scientific literature. Dr. Ovaska is a principal investigator of an ongoing project addressing the use terrestrial gastropods as indicators of forest-floor conditions in relation to different logging practices (project conducted for Weyerhaeuser Company Limited, 1999–2001). She is also a principal investigator of a study dealing with the distribution of terrestrial gastropods deemed to be at risk in southwestern British Columbia (2000–2001; funded, in part, by the Endangered Species Recovery Fund and Wildlife Habitat Canada).

Robert Forsyth is a dedicated amateur malacologist who since 1990 has travelled extensively throughout B.C. studying terrestrial molluscs. He is the author of 10 refereed papers on British Columbia terrestrial molluscs and is currently completing an identification guide to the land snails and slugs of British Columbia. Mr. Forsyth is a research associate with the Royal British Columbia Museum and is active in fieldwork, identification and research. With Dr. Ovaska, he is also investigating the distribution of terrestrial gastropods deemed to be at risk in southwestern British Columbia (2000–2001; funded, in part, by the Endangered Species Recovery Fund and Wildlife Habitat Canada). Mr. Forsyth is a member of COSEWIC's Mollusca Species Specialist Group.

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COLLECTIONS EXAMINED

Computerized databases of the following institutions were searched:

Canadian Museum of Nature, P.O. Box 3443, Stn. D, Ottawa, ON, Canada K1P 6P4

Delaware Museum of Natural History, 4840 Kennett Pike, P.O. Box 3937, Wilmington, DE, USA 19807-0937

The Field Museum of Natural History, 1400 S. Lake Shore Drive, Chicago, IL, USA 60605-2496

The Philadelphia Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadephia, PA, USA 19103

Royal British Columbia Museum, 675 Belleville Street, Victoria, BC, Canada V8V 1X4

Royal Ontario Museum, 100 Queen's Park, Toronto, Ottawa, ON, Canada M5S 2G6

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